(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 939 632 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
13.10.2021 Bulletin 2021/41

(21) Application number: **13868654.8**

(22) Date of filing: **25.12.2013**

(51) Int Cl.:
A61B 34/35 *(2016.01)* ***B25J 9/16*** *(2006.01)*

(86) International application number:
PCT/JP2013/084647

(87) International publication number:
WO 2014/104088 (03.07.2014 Gazette 2014/27)

(54) SURGICAL ROBOT

CHIRURGISCHER ROBOTER

ROBOT CHIRURGICAL

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **25.12.2012 JP 2012281613**

(43) Date of publication of application:
04.11.2015 Bulletin 2015/45

(73) Proprietor: **Kawasaki Jukogyo Kabushiki Kaisha**
Kobe-shi, Hyogo 650-8670 (JP)

(72) Inventors:
- **KAMON, Masayuki**
  Akashi-shi
  Hyogo 673-8666 (JP)
- **NOGUCHI, Kenji**
  Akashi-shi
  Hyogo 373-8666 (JP)

(74) Representative: **AWA Sweden AB**
Junkersgatan 1
582 35 Linköping (SE)

(56) References cited:
WO-A2-2007/137304
WO-A2-2011/116332
JP-A- H05 337 118
JP-A- H08 280 709
JP-A- 2001 104 333
JP-A- 2002 253 574
US-A1- 2009 192 524
US-A1- 2010 198 402
US-A1- 2010 228 249
US-A1- 2011 306 986

EP 2 939 632 B1

Description

Technical Field

[0001] The present invention relates to a surgical robot for supporting a surgery using a plurality of medical instruments.

Background Art

[0002] Conventionally, it is proposed that, in a surgical robot of a master/slave system, an image obtained from an endoscope related to a surgical site of a patient is presented to an operator (doctor), and a movement direction of a tip end of a medical instrument is composed so as to be presented to the same (Patent Document 1). Also, it is known that a plurality of medical instruments are operated by a common input portion of the surgical robot.

[0003] Conventionally, when a medical instrument to be operated is selected from a plurality of medical instruments so as to be operated by the common input portion of the surgical robot, operation directions of all medical instruments are displayed at the same time regardless of whether it is selected or not (Patent Document 1).

[0004] US 2010/228249 A1 discloses user interfaces for electrosurgical tools in robotic surgical systems.

[0005] WO 2011/116332 A2 discloses a surgical cockpit comprising multisensory and multimodal interfaces for robotic surgery and methods related thereto.

[0006] WO 2007/137304 A2 discloses an electrical surgical instrument.

[0007] US 2010/198402 A1 discloses methods, devices and systems for non-mechanically restricting and/or programing movement of a tool of a manipulator along a single axis.

[0008] US2011/306986 A1 discloses a surgical robot system using augmented reality and method for controlling the same.

Related Documents

Patent Document

[0009] [Patent Document 1] Japanese Patent Application Laid-Open No. 2001-104333

Summary of Invention

Problems to be Solved by the Invention

[0010] However, in the conventional surgical robot (Patent Document 1), an operator cannot easily judge which medical instrument has been selected and which switch of a plurality of switches or the like provided to the input portion of the surgical robot corresponds to which movement of the selected medical instrument.

[0011] The present invention has been made to deal with the above-mentioned problems of a conventional technique, aiming to provide a surgical robot capable of enabling an operator to easily judge which medical instrument has been selected.

[0012] Also, the present invention aims to provide a surgical robot capable of enabling an operator to easily judge which switch corresponds to which movement of a selected medical instrument.

Means for Solving the Problems

[0013] The invention is defined by the appended claims.

[0014] In order to solve the above-mentioned problems, a surgical robot of the present invention includes a robot body configured to selectively operate a plurality of medical instruments; an input unit configured to input a control information of the robot body, the input unit being common among the plurality of medical instruments; and a display unit configured to display an image of a surgical site of a patient, the display unit having a selecting situation display function which displays a selecting situation of the plurality of medical instruments.

[0015] Also, the display unit is to display on a screen of the display unit a mark and/or a letter for identifying the medical instrument which has been selected.

[0016] Also, the mark and/or letter is/are displayed so as to be overlapped at least partially on the medical instrument.

[0017] Also, it is preferable that the display unit has a function which invalidates the selecting situation display unit.

[0018] Also, the input unit has a plurality of operation portions which correspond to a plurality of operation contents of the medical instruments, wherein the plurality of operation portions are provided with operated state detection units which are configured to detect operated states of respective operation portions, and wherein the display unit has an operation contents display function which displays an operation content of the medical instrument corresponding to the operation portion whose operated state has been detected by the operated state detection unit.

[0019] Also, it is preferable that the operation contents display function is to display a mark which is suggestive of the operation content.

[0020] Also, it is preferable that the mark which is suggestive of the operation content is displayed so as to be overlapped at least partially on the medical instrument.

[0021] Also, it is preferable that the operation contents display function erases a display of the operation content when a given time has passed after displaying the operation content on a screen of the display unit.

[0022] Also, it is preferable that the display unit has a function which invalidates the operation contents display function.

[0023] Also, it is preferable that the operated state detection unit is a contact and/or a proximity sensor.

[0024] Also, the operation portion has a first operation state and a second operation state that an operation progresses further from the first operation state, and wherein the operation contents display function is to display the operation content of the medical instrument in the first operation state.

[0025] Also, the operation portion includes a push-button type switch, and wherein the first operation state is a half-depressed state of the push-button type switch, and the second operation state is a state that the push-button type switch is depressed further from the half-depressed state.

[0026] Also, it is preferable that the display unit further has a switch display function which displays various switches, and wherein the input unit has an operation portion configured to actuate a desired switch among the various switches.

[0027] Also, it is preferable that the input unit comprises a plurality of input units, the display unit having a plurality of displays which correspond to the plurality of input units respectively.

[0028] Also, it is preferable that the input unit has a movable operation portion configured to move at least one of the plurality of medical instruments, and wherein the display unit sets a magnification of an operation amount of the medical instrument with respect to an operation amount of the movable operation portion to a reciprocal of a display magnification of the medical instrument.

Advantageous Effect of the Invention

[0029] The surgical robot of the present invention enables an operator to easily judge which medical instrument has been selected because a selecting situation on a plurality of medical instruments is displayed by a display unit for displaying an image of a surgical site of a patient.

Brief Description of the Drawings

[0030]

FIG. 1 is a schematic view illustrating an outline of a surgical robot according to an embodiment of the present invention.

FIG. 2A is a plan view enlarging and schematically illustrating an operation panel of an input unit of the surgical robot illustrated in FIG. 1.

FIG. 2B is a perspective view enlarging and schematically illustrating the operation panel of the input unit of the surgical robot illustrated in FIG. 1.

FIG. 3 is a schematic view illustrating a display example of a display of the surgical robot illustrated in FIG. 1.

FIG. 4 is a schematic view for explaining a function of the surgical robot illustrated in FIG. 1.

FIG. 5 a schematic view for explaining a function of the surgical robot illustrated in FIG. 1.

FIGs. 6A and 6B are schematic views illustrating a modified example of the surgical robot illustrated in FIG. 1; FIG. 6A illustrates a display example of a display, and FIG. 6B illustrates an operation panel of an input unit.

FIGs. 7A and 7B are schematic views illustrating another modified example of the surgical robot illustrated in FIG. 1; FIG. 7A illustrates a display example of a display, and FIG. 7B illustrates an operation panel of an input unit.

FIG. 8 is a schematic view illustrating another modified example of the surgical robot illustrated in FIG. 1.

FIGs. 9A and 9B are schematic views for explaining a function of another modified example of the surgical robot illustrated in FIG. 2; FIG. 9A illustrates a screen when a display magnification is 1, and FIG. 9B illustrates a screen when a display magnification is 2.

Embodiment of the Invention

[0031] Hereunder, the surgical robot according to an embodiment of the present invention will be described with reference to FIGS. 1 to 5.

[0032] As illustrated in FIG.1, a surgical robot 1 of the present embodiment is provided with a robot body 4 having a robot arm 3 with a tip end to which a medical instrument 2 (2A, 2B, 2C) is mounted. Note that an illustration of the robot arm 3 to which the medical instruments 2B, 2C are mounted is omitted in FIG. 1. Control information of the robot body 4 is input to a control unit 7 by an input unit 6 which is provided with a control panel 5.

[0033] The control unit 7 controls the robot body 4 based on control information which is input from the input unit 6. The robot body 4 selectively operates a plurality of different kinds of medical instruments 2, and the common input unit 6 is used for a plurality of medical instruments 2. As the medical instrument 2, an instrument which clamps or cuts a surgical site or the like can be used, for example.

[0034] The surgical robot 1 further has an endoscope (not illustrated) for imaging a surgical site of a patient P, and a display 8 is installed adjacent to the operation panel 5 in order to present an image obtained from the endoscope to an operator.

[0035] An image of the display 8 is controlled by the control unit 7, and a display unit 9 in the surgical robot 1 of the present embodiment is configured by the display 8 and (a display control portion of) the control unit 7.

[0036] In FIG. 2A and FIG. 2B, the operation panel 5 of the input unit 6 is displayed so as to be enlarged, and the operation panel 5 is provided with a selection switch (operation portion)10 (10A, 10B, 10C) for selecting the medical instrument 2 to be used from a plurality of (three in the embodiment) medical instruments 2, a joystick (operation portion or movable operation portion) 11 for moving the selected medical instrument 2, and a startup

switch (operation portion) 12 (12A, 12B, 12C, 12D) for performing various operations (four kinds in the example) by the selected medical instrument 2. The joystick 11 may be provided with the startup switch 12.

[0037] Each joint of the robot arm 3 is provided with a joint angle sensor (encoder, for example) for detecting a joint angle. Information of the joint angle sensor is transmitted to the control unit 7, and the control unit 7 recognizes the attitude of the robot arm 3 based on the transmitted information.

[0038] If a relative positional relation between each robot arm 3 on which each medical instrument 2 is mounted is known, the control unit 7 can recognize a relative positional relation of each medical instrument 2 and an endoscope by recognizing an attitude of each robot arm 3 as mentioned above.

[0039] The control unit 7 can recognize that the medical instruments 2A, 2B, 2C on the screen correspond to which of the selection switches 10A, 10B, 10C based on the relative positional relation of the respective medical instruments 2 and the endoscope which is recognized in this manner, and an image imaged by the endoscope.

[0040] Also, contact/proximity sensors (operated state detection units) 13 are provided to the joystick 11 and the startup switches 12 respectively. In addition to a mechanical sensor such as a switch or the like, various types of electric sensors including electrostatic capacitance type or the like can be used as the contact/proximity sensor 13. A detection signal of the contact/proximity sensor 13 is transmitted to the control unit 7, and thereby the operation portions 10, 11, 12 to be operated can be identified.

[0041] FIG. 3 illustrates a display example of the display 8. The display unit 9 has a selected condition display function of displaying the selected condition of a plurality of medical instruments 2 on the screen. Also, the display unit 9 has a function of displaying moving directions and functions of the medical instruments 2 on the screen of the display 8.

[0042] In the example illustrated in FIG. 3, the selection switch 10B of the operation panel 5 is pressed so as to select the medical instrument 2B, and a star-shaped mark (mark) 14 is displayed in the selected medical instrument 2B on the screen of the display 8.

[0043] Thus, as the selected medical instrument 2B can be confirmed with the mark 14 on the display 8, the operator can easily recognize the currently selected medical instrument 2B without taking his/her eyes off the display 8.

[0044] The mark 14 is displayed on the screen of the display 8 so as to be at least partially overlapped on the selected medical instrument 2B. Thereby, the selected medical instrument 2B can be easily recognized and also the mark 14 does not cut off a view, and therefore an image area of the display 8 can be used further efficiently.

[0045] Also, the mark 14 which indicates the selected medical instrument 2B can be constantly displayed on the display 8.

[0046] Also, the selected medical instrument 2B can be displayed on the screen of the display 8 with letters (letters such as "Electrosurgical Instrument", for example) as well as the display of the mark 14 which indicates the selected medical instrument 2B.

[0047] Also, the mark 14 may indicate the medical instrument 2B with an arrow in addition to a pattern such as a star-shaped mark as in the example. Namely, it would be sufficient for the way of display that the selected medical instrument 2B can be distinguished from the other medical instruments 2A, 2C. Note that, when two or more medical instruments 2 are selected at the same time, the mark 14 is attached to the respective medical instruments 2.

[0048] Also, the display unit 9 has a function of invalidating the selected condition display function. In some cases, the selected condition of the medical instrument 2 does not necessarily need to be displayed on the display 8 depending on the contents of a surgery performed and the type of the medical instrument 2 used. In such cases, the display function of the display 8 can be used effectively by preventing useless display on the display 8.

[0049] Also, the display unit 9 has an operation contents display function of displaying operation contents of the medical instruments 2 corresponding to the operation portions 11, 12 of which operated states are detected by the contact/proximity sensors 13 which are provided to the joystick 11 and the startup switch 12.

[0050] The screen of the display 8 on the left side in FIG. 4 displays a mark 15 adjacent to the selected medical instrument 2B and suggestive of operation contents (moving direction in this case) when an operator holds the joystick 11 in the state that the selection switch 10B is pressed so as to select the medical instrument 2B.

[0051] On the other hand, the screen of the display 8 on the right side in FIG. 4 displays the mark 15 adjacent to the selected medical instrument 2B and suggestive of operation contents (energization to the electrosurgical instrument in this case) when an operator makes contact with the startup switch 12D in the same state that the medical instrument 2B is selected.

[0052] Note that, on the screen of the display 8, the mark 15 suggestive of operation contents can be displayed so as to be at least partially overlapped on the medical instrument 2. Thereby, an operator can easily recognize operation contents of the medical instrument 2 and also the image area of the display 8 can be efficiently used as the mark 15 does not cut off a view.

[0053] Also, operation contents can be displayed on the screen of the display 8 with a letter 16 ("Energization", for example) as well as display of the mark 15 suggestive of operation contents.

[0054] Also, the mark 15 and the letter 16 indicating operation contents of the medical instrument 2 can be constantly displayed on the display 8, while the mark 15 and a letter 16 may be erased when a predetermined time has passed (after one second, for example) after mark 15 and a letter 16 have been displayed. Thereby,

the image area of the display 8 can be used further efficiently.

[0055] Also, the display unit 8 has a function of invalidating the operation contents display function. In some cases, operation contents of the medical instrument 2 do not necessarily need to be displayed on the display 8 depending on the contents of a surgery performed and the type of the medical instrument 2 used. In such cases, the display function of the display 8 can be used effectively by preventing useless display on the display 8.

[0056] The screen of the display 8 on the left side in FIG. 5 displays the mark 15 adjacent to the selected medical instrument 2A and suggestive of operation contents (moving direction in this case) when an operator holds the joystick 11 in the state that the selection switch 10A is pressed so as to select the medical instrument 2A.

[0057] On the other hand, the screen of the display 8 on the right side in FIG. 5 displays the mark 15 adjacent to the selected medical instrument 2A and suggestive of operation contents (operation of closing a forceps in this case) when an operator makes contact with the startup switch 12D in the same state that the medical instrument 2A is selected.

[0058] As can be seen from FIG. 4 and FIG. 5, in the surgical robot 1 of the embodiment, different medical instruments (medical instruments 2A, 2B, for example) can be operated with the common startup switch (startup switch 12D, for example), and therefore the number of the startup switches 12 to be installed can be decreased.

[0059] Additionally, as operation contents are displayed on the screen of the display 8 according to the selected medical instrument 2, an operator can recognize the operation contents easily even when different medical instruments 2 are operated by the common startup switch 12.

[0060] As a modified example of the surgical robot 1 according to the above-described embodiment, the operation portion such as the startup switch 12 is configured by a switch which has a first operation state and a second operation state that an operation further progresses from the first operation state, and also the operation contents display function displays operation contents of the medical instrument 2 in the first operation state.

[0061] For example, when the operation portion such as the startup switch 12 is configured by a push-button type switch, the first operation state is a half-depressed state of the push-button type switch, and the second operation state is a state that the push-button type switch is depressed further from the half-depressed state.

[0062] In the modified example, at the time when the operation portion (push-button type switch, for example) reaches the second operation state (state of being depressed further from the half-depressed state), the corresponding medical instrument 2 performs a predetermined operation (energization to the electrosurgical instrument, for example).

[0063] As another modified example of the surgical robot 1 according to the above-described embodiment, voice guidance can be used together with the marks 14, 15 and the letter 16 by the display unit 9.

[0064] Also, as the operation portions 10, 11, 12, a passive arm with multiple degrees of freedom and a grip or the like which detects gripping amount may be used in addition to the above-mentioned switch and joystick.

[0065] As another modified example of the surgical robot 1 according to the above-described embodiment, the display unit 9 may further have a switch display function of displaying various switches other than the joystick 11 on the display 8 so as to operate the switches by movements of a pointer (cursor) on the display 8 and clicks.

[0066] For example, as illustrated in FIGs. 6A and 6B, a pointer 17 displayed on the display 8 is moved by the joystick 11 so as to move the pointer 17 to the position of a desired switch of a slave screen 18 displayed similarly on the display 8. Here, in the example illustrated in FIG. 6A, the slave screen 18 configures a selection switch for selecting various medical instruments 2A, 2B, 2C.

[0067] Once the pointer 17 is moved to the position of the desired selection switch ("Instrument B" in FIG. 6A) of the slave screen 18 by operating the joystick 11, an operation button 19 provided to an end portion of the joystick 11 is pressed so as to select a desired medical instrument.

[0068] Thereby, since the star-shaped mark (mark) 14 is displayed in the selected medical instrument 2B as illustrated in FIG. 6A, an operator can easily recognize the currently selected medical instrument 2B without taking his/her eyes of the operator off the display 8.

[0069] Additionally, in the modified example, an operation itself for selecting the desired medical instrument 2 can be also performed without taking his/her eyes of the operator off the display 8. Also, the selection switches 10A, 10B, 10C of the operation panel 5 can be omitted.

[0070] Also, the operation button 19 provided to the end portion of the joystick 11 may be used as a startup switch for starting up the selected medical instrument 2B.

[0071] In this manner, an operator can start up the desired medical instrument 2B without taking his/her eyes of the operator off the display 8. Also, the startup switches 12A, 12B, 12C, 12D of the operation panel 5 can be omitted.

[0072] FIGs. 7A and 7B illustrates another modified example, and when the pointer 17 is positioned on the switch of the slave screen 18 displayed on the display 8, the medical instrument 2 concerned with the switch is specified in this modified example.

[0073] For example, when the pointer 17 is positioned to a switch "×2" as illustrated in FIG. 7A, the star-shaped mark (mark) 14 is displayed in a medical instrument (medical instrument 2B in FIG. 7A) whose magnification rate becomes 2 times thereby. Here, the "magnification rate" is a magnification of operation amount of the medical instrument 2 or the like with respect to operation amount of the joystick (operation portion) 11.

[0074] FIG. 8 illustrates another modified example, and a plurality of input units (consoles) 6 are provided

for one surgical robot 1 in this example. In this example, three input units 6A, 6B, 6C are installed.

[0075] Additionally, on the respective displays 8A, 8B, 8C of the plurality of input units 6A, 6B, 6C, common information to each other can be displayed. Therefore, operators can recognize via the displays 8 of their own that which switches of medical instruments 2 are being touched by other operators and which operation they are to perform.

[0076] According to the modified example, a plurality of operators can recognize each other's operation situation without taking their eyes off their displays upon co-operating, and therefore the co-operation can be performed smoothly.

[0077] Note that, although FIG. 8 illustrates an example that the displays 8 and the control units 7 are provided to the respective medical instruments 2, a common display or a control unit may be employed.

[0078] As another modified example, the above-mentioned magnification rate may be the reciprocal of the display magnification of the display 8.

[0079] Namely, this modified example enables an intuitive operation by maintaining operation amount of the medical instrument 2 on the display 8 with respect to certain operation amount of the joystick (operation portion) 11 regardless of display magnification.

[0080] For example, operation amount of the medical instrument 2 on the display 8 when the joystick (operation portion) 11 is moved 1cm to the left is shown by the length of an arrow illustrated in FIG. 9A.

[0081] On the other hand, when the display magnification of the display 8 is increased to 2, operation amount of the medical instrument 2 with respect to operation amount of the joystick (operation portion) 11 is 1/2 as the reciprocal of 2. Thereby, operation amount of the medical instrument 2 on the display 8 when the operation portion 11 is moved 1cm to the left is shown by an arrow in FIG. 9B, and it has the same length as the length of the arrow in FIG. 9A.

[0082] Namely, operation amount of the medical instrument 2 on the display 8 corresponding to a fixed operation amount of the joystick (operation amount) 11 is obtained by (display magnification of display) $\times$ (1/display magnification of display) = 1 time, being constant regardless of magnification rate.

[0083] Thus, as a ratio of operation amount of the medical instrument 2 on the display 8 to operation amount of the joystick (operation portion) 11 is constant regardless of display magnification, an intuitive operation becomes possible.

[0084] Also, in such a case, a relation between a movable range of the joystick (operation portion) 11 and a display range of the display 8 also becomes constant, and thereby a movable range according to a display range and a display range according to a movable range can be set easily, which is advantageous on this point as well.

[0085] As described above, in the surgical robot 1 according to the embodiment and the modified examples thereof, the selected medical instrument 2 and the correspondence relation between the operation portions 11, 12 of the input unit 6 and the operation contents of the medical instrument 2 are displayed on the screen of the display 8, and thereby an operator can easily judge which medical instrument 2 is selected or which operation portions 11, 12 of the input unit 6 correspond to which operation of the medical instrument 2 via the screen of the display 8, namely, without taking his/her eyes off the display 8.

Explanation of Reference Numerals

[0086]

1 ... surgical robot
2, 2A, 2B, 2C ... medical instrument
3 ... robot arm
4 ... robot body
5 ... operation panel
6, 6A, 6B, 6C ... input unit
7 ... control unit
8, 8A, 8B, 8C ... display
9 ... display unit
10(10A, 10B, 10C) ... selection switch (operation portion)
11 ... joystick (operation portion or movable operation portion)
12(12A, 12B, 12C, 12D)... startup switch (operation portion)
13 ... contact/proximity sensor (operated state detection unit)
14, 15 ... mark
16 ... letter
17 ... pointer
18 ... slave screen
19 ... operation button
P ... patient

Claims

1. A surgical robot (1), comprising:

an endoscope providing an image of a surgical site of a patient (P);
a robot body (4) configured to selectively operate a plurality of medical instruments (2, 2A, 2B, 2C), wherein the robot body (4) comprises a plurality of robot arms (3), each with a tip end to which a medical instrument of the plurality of medical instruments (2, 2A, 2B, 2C) is mounted and wherein each joint of the robot arms (3) comprises a joint angle sensor;
an input unit (6, 6A, 6B, 6C) configured to input a control information for controlling at least one medical instrument (2, 2A, 2B, 2C), the input unit

(6, 6A, 6B, 6C) being operatively connected to the plurality of medical instruments (2, 2A, 2B, 2C);
a control unit (7) configured to control the robot body (4) based on the control information which is input from the input unit (6, 6A, 6B, 6C), the control unit (7) being further configured to detect the relative position of the robot arms using the information of the joint angle sensors in order to recognize the plurality of medical instruments on the image of a surgical site of a patient (P);
a display unit (9) configured to display the image of a surgical site of a patient in real time on a display (8),
wherein the display unit (9) receives instructions from the control unit (7) to display a mark (14) and/or a letter superposed over the real time image of the surgical site, the mark (14) and/or the letter identifying the at least one medical instrument (2, 2A, 2B, 2C) corresponding to the inputted control information;
wherein the mark (14) and/or letter is/are displayed so as to be overlapped at least partially on the medical instrument (2, 2A, 2B, 2C), or adjacent to the identified medical instrument (2, 2A, 2B, 2C),
wherein the mark (14) and/or letter is/are constantly displayed; and
wherein the input unit (6, 6A, 6B, 6C) has a plurality of operation portions (10, 11, 12) which correspond to a plurality of operation contents of the respective medical instruments (2, 2A, 2B, 2C),
wherein the plurality of operation portions (10, 11, 12) are provided with operated state detection units (13) which are configured to detect operated states of respective operation portions (10, 11, 12); wherein at least one of the plurality of the operation portions (10, 11, 12) has a first operation state and a second operation state that an operation progresses further from the first operation state,
wherein said operation portion includes a push-button type switch, and
wherein the first operation state is a half-depressed state of the push-button type switch, and the second operation state is a state that the push-button type switch is depressed further from the half-depressed state; and
wherein the control unit (7) is configured to identify an operation portion (10, 11, 12) to be operated, based on a detection signal of the operated state detection units (13) transmitted to the control unit (7);
wherein the display unit (9) has an operation contents display function which displays the operation content of the medical instrument (2, 2A, 2B, 2C) corresponding to the operation portion (10, 11, 12) whose operated state has been detected by the operated state detection units (13); wherein when said operation portion is in the first operation state, the operation contents display function is to display the operation content of the corresponding medical instruments (2, 2A, 2B, 2C), and

when said operation portion reaches the second operation state, the corresponding medical instrument (2, 2A, 2B, 2C) is configured to performs a predetermined operation.

2. The surgical robot (1) according to claim 1, wherein the display unit (9) has a function that can be selected to disable the display of the mark (14) and/or letter.

3. The surgical robot (1) according to any of claims 1 to 2, wherein the operation contents display function is to display a mark (15) which is suggestive of the operation content.

4. The surgical robot (1) according to claim 3, wherein the mark (15) which is suggestive of the operation content is displayed so as to be overlapped at least partially on the medical instrument (2, 2A, 2B, 2C).

5. The surgical robot (1) according to any one of claims 1 to 4, wherein the operation contents display function erases a display of the operation content when a given time has passed after displaying the operation content on the screen (8, 8A, 8B, 8C) of the display unit (9).

6. The surgical robot (1) according to any one of claims 1 to 5, wherein the display unit (9) has a function which invalidates the operation contents display function.

7. The surgical robot (1) according to any one of claims 1 to 6, wherein the operated state detection unit is a contact and/or a proximity sensor (13).

8. The surgical robot (1) according to any one of claims 1 to 7, wherein the display unit (9) further has a switch display function which displays various switches, and
wherein the input unit (6, 6A, 6B, 6C) has an operation portion configured to actuate a desired switch among the various switches.

9. The surgical robot (1) according to any one of claims 1 to 8, wherein the input unit (6, 6A, 6B, 6C) comprises a plurality of input units (6, 6A, 6B, 6C), the display unit (9) having a plurality of displays which correspond to the plurality of input units (6, 6A, 6B, 6C) respectively.

10. The surgical robot (1) according to any one of claims 1 to 9, wherein the input unit (6, 6A, 6B, 6C) has a movable operation portion configured to move at least one of the plurality of medical instruments (2, 2A, 2B, 2C), and
wherein the display unit (9) sets a magnification of an operation amount of the medical instrument (2, 2A, 2B, 2C) with respect to an operation amount of the movable operation portion to a reciprocal of a display magnification of the medical instrument (2, 2A, 2B, 2C).

Patentansprüche

1. Chirurgischer Roboter (1), der umfasst:

ein Endoskop, das ein Bild einer Operationsstelle eines Patienten (P) bereitstellt;
einen Roboterkörper (4), der dazu ausgestaltet ist, selektiv mehrere medizinische Instrumente (2, 2A, 2B, 2C) zu betätigen, wobei der Roboterkörper (4) mehrere Roboterarme (3), jeweils mit einem Spitzenende, an dem ein medizinisches Instrument von den mehreren medizinischen Instrumenten (2, 2A, 2B, 2C) montiert ist, umfasst, und
wobei jedes Gelenk der Roboterarme (3) einen Gelenkwinkelsensor umfasst;
eine Eingabeeinheit (6, 6A, 6B, 6C), die dazu ausgestaltet ist, eine Steuerungsinformation zum Steuern von mindestens einem medizinischen Instrument (2, 2A, 2B, 2C) einzugeben, wobei die Eingabeeinheit (6, 6A, 6B, 6C) betriebsfähig mit den mehreren medizinischen Instrumenten (2, 2A, 2B, 2C) verbunden ist;
eine Steuereinheit (7), die dazu ausgestaltet ist, den Roboterkörper (4) basierend auf den Steuerungsinformationen zu steuern, die von der Eingabeeinheit (6, 6A, 6B, 6C) eingegeben werden, wobei die Steuereinheit (7) ferner dazu ausgestaltet ist, die relative Position der Roboterarme unter Verwendung der Informationen der Gelenkwinkelsensoren festzustellen, um die mehreren medizinischen Instrumente auf dem Bild einer Operationsstelle eines Patienten (P) zu erkennen;
eine Anzeigeeinheit (9), die dazu ausgestaltet ist, das Bild einer Operationsstelle eines Patienten in Echtzeit auf einer Anzeige (8) anzuzeigen,
wobei die Anzeigeeinheit (9) Anweisungen von der Steuereinheit (7) empfängt, um eine Markierung (14) und/oder einen Buchstaben über dem Echtzeitbild der Operationsstelle überlagert anzuzeigen, wobei die Markierung (14) und/oder der Buchstabe das mindestens eine medizinische Instrument (2, 2A, 2B, 2C) identifiziert, das den eingegebenen Steuerungsinformationen entspricht;
wobei die Markierung (14) und/oder der Buchstabe so angezeigt wird/werden, dass sie zumindest teilweise auf dem medizinischen Instrument (2, 2A, 2B, 2C) überlappt oder dem identifizierten medizinischen Instrument (2, 2A, 2B, 2C) benachbart ist/sind,
wobei die Markierung (14) und/oder der Buchstabe konstant angezeigt wird/werden; und
wobei die Eingabeeinheit (6, 6A, 6B, 6C) mehrere Betätigungsabschnitte (10, 11, 12) aufweist, die mehreren Betätigungsinhalten der entsprechenden medizinischen Instrumente (2, 2A, 2B, 2C) entsprechen,
wobei die mehreren Betätigungsabschnitte (10, 11, 12) mit Einheiten (13) zur Feststellung betätigter Zustände versehen sind, die dazu ausgestaltet sind, betätigte Zustände von entsprechenden Betätigungsabschnitten (10, 11, 12) festzustellen; wobei mindestens einer von den mehreren Betätigungsabschnitten (10, 11, 12) einen ersten Betätigungszustand und einen zweiten Betätigungszustand aufweist, zu dem eine Betätigung von dem ersten Betätigungszustand weiter fortschreitet,
wobei der Betätigungsabschnitt einen Schalter vom Typ eines Druckknopfs umfasst, und
wobei der erste Betätigungszustand ein halb gedrückter Zustand des Schalters vom Typ eines Druckknopfs ist und der zweite Betätigungszustand ein Zustand ist, in dem der Schalter vom Typ eines Druckknopfs von dem halb gedrückten Zustand weiter gedrückt ist; und
wobei die Steuereinheit (7) dazu ausgestaltet ist, einen zu betätigenden Betätigungsabschnitt (10, 11, 12) basierend auf einem Feststellungssignal der Einheiten (13) zur Feststellung des betätigten Zustands, das an die Steuereinheit (7) gesendet wird, zu identifizieren;
wobei die Anzeigeeinheit (9) eine Betätigungsinhalte-Anzeigefunktion aufweist, die den Betätigungsinhalt des medizinischen Instruments (2, 2A, 2B, 2C) anzeigt, das dem Betätigungsabschnitt (10, 11, 12) entspricht, dessen betätigter Zustand durch die Einheiten (13) zur Feststellung des betätigten Zustands festgestellt wurde;
wobei, wenn der Betätigungsabschnitt sich im ersten Betätigungszustand befindet, die Betätigungsinhalte-Anzeigefunktion dazu bestimmt ist, den Betätigungsinhalt der entsprechenden medizinischen Instrumente (2, 2A, 2B, 2C) anzuzeigen, und
wenn der Betätigungsabschnitt den zweiten Betätigungszustand erreicht, das entsprechende medizinische Instrument (2, 2A, 2B, 2C) dazu ausgestaltet ist, eine vorbestimmte Betätigung durchzuführen.

2. Chirurgischer Roboter (1) nach Anspruch 1, wobei die Anzeigeeinheit (9) eine Funktion aufweist, die ausgewählt werden kann, um die Anzeige der Markierung (14) und/oder des Buchstabens zu deaktivieren.

3. Chirurgischer Roboter (1) nach einem der Ansprüche 1 bis 2, wobei die Betätigungsinhalte-Anzeigefunktion dazu bestimmt ist, eine Markierung (15) anzuzeigen, die auf den Betätigungsinhalt hinweist.

4. Chirurgischer Roboter (1) nach Anspruch 3, wobei die Markierung (15), die auf den Betätigungsinhalt hinweist, so angezeigt wird, dass sie das medizinische Instrument (2, 2A, 2B, 2C) zumindest teilweise überlappt.

5. Chirurgischer Roboter (1) nach einem der Ansprüche 1 bis 4, wobei die Betätigungsinhalte-Anzeigefunktion eine Anzeige des Betätigungsinhalts löscht, wenn eine gegebene Zeit nach dem Anzeigen des Betätigungsinhalts auf dem Bildschirm (8, 8A, 8B, 8C) der Anzeigeeinheit (9) verstrichen ist.

6. Chirurgischer Roboter (1) nach einem der Ansprüche 1 bis 5, wobei die Anzeigeeinheit (9) eine Funktion aufweist, die die Betätigungsinhalte-Anzeigefunktion außer Kraft setzt.

7. Chirurgischer Roboter (1) nach einem der Ansprüche 1 bis 6, wobei die Einheit zur Feststellung des betätigten Zustands ein Kontakt- und/oder ein Näherungssensor (13) ist.

8. Chirurgischer Roboter (1) nach einem der Ansprüche 1 bis 7, wobei die Anzeigeeinheit (9) ferner eine Schalteranzeigefunktion aufweist, die verschiedene Schalter anzeigt, und
wobei die Eingabeeinheit (6, 6A, 6B, 6C) einen Betätigungsabschnitt aufweist, der dazu ausgestaltet ist, einen gewünschten Schalter unter den verschiedenen Schaltern zu betätigen.

9. Chirurgischer Roboter (1) nach einem der Ansprüche 1 bis 8, wobei die Eingabeeinheit (6, 6A, 6B, 6C) mehrere Eingabeeinheiten (6, 6A, 6B, 6C) umfasst, wobei die Anzeigeeinheit (9) mehrere Anzeigen aufweist, die jeweils den mehreren Eingabeeinheiten (6, 6A, 6B, 6C) entsprechen.

10. Chirurgischer Roboter (1) nach einem der Ansprüche 1 bis 9, wobei die Eingabeeinheit (6, 6A, 6B, 6C) einen beweglichen Betätigungsabschnitt aufweist, der dazu ausgestaltet ist, mindestens eines von den mehreren medizinischen Instrumenten (2, 2A, 2B, 2C) zu bewegen, und
wobei die Anzeigeeinheit (9) eine Vergrößerung eines Betätigungsbetrags des medizinischen Instruments (2, 2A, 2B, 2C) in Bezug auf einen Betätigungsbetrag des beweglichen Betätigungsabschnitts auf einen Reziprokwert einer Bildschirmvergrößerung des medizinischen Instruments (2, 2A, 2B, 2C) einstellt.

Revendications

1. Robot chirurgical (1), comprenant :

un endoscope fournissant une image d'un site chirurgical d'un patient (P) ;
un corps de robot (4) configuré pour actionner sélectivement une pluralité d'instruments médicaux (2, 2A, 2B, 2C), dans lequel le corps de robot (4) comprend une pluralité de bras de robot (3), chacun d'eux comportant une extrémité de pointe à laquelle un instrument médical parmi la pluralité d'instruments médicaux (2, 2A, 2B, 2C) est monté et
dans lequel chaque articulation des bras de robot (3) comprend un capteur d'angle d'articulation ;
une unité de saisie (6, 6A, 6B, 6C) configurée pour saisir une information de commande pour commander au moins un instrument médical (2, 2A, 2B, 2C), l'unité de saisie (6, 6A, 6B, 6C) étant reliée fonctionnellement à la pluralité d'instruments médicaux (2, 2A, 2B, 2C) ;
une unité de commande (7) configurée pour commander le corps de robot (4) sur la base de l'information de commande qui est saisie depuis l'unité de saisie (6, 6A, 6B, 6C), l'unité de commande (7) étant en outre configurée pour détecter la position relative des bras de robot en utilisant les informations des capteurs d'angle d'articulation afin de reconnaître la pluralité d'instruments médicaux sur l'image d'un site chirurgical d'un patient (P) ;
une unité d'affichage (9) configurée pour afficher l'image d'un site chirurgical d'un patient en temps réel sur un affichage (8),
dans lequel l'unité d'affichage (9) reçoit des instructions depuis l'unité de commande (7) pour afficher une marque (14) et/ou une lettre superposées sur l'image en temps réel du site chirurgical, la marque (14) et/ou la lettre identifiant l'au moins un instrument médical (2, 2A, 2B, 2C) correspondant à l'information de commande saisie ;
dans lequel la marque (14) et/ou la lettre sont affichées de manière à chevaucher au moins partiellement l'instrument médical (2, 2A, 2B, 2C) ou à être adjacentes à l'instrument médical (2, 2A, 2B, 2C) identifié,
dans lequel la marque (14) et/ou la lettre sont constamment affichées ; et

dans lequel l'unité de saisie (6, 6A, 6B, 6C) a une pluralité de portions d'actionnement (10, 11, 12) qui correspondent à une pluralité de contenus d'actionnement des instruments médicaux (2, 2A, 2B, 2C) respectifs,
dans lequel la pluralité de portions d'actionnement (10, 11, 12) sont pourvues d'unités de détection d'état actionné (13) qui sont configurées pour détecter des états actionnés de portions d'actionnement (10, 11, 12) respectives ; dans lequel au moins l'une de la pluralité de portions d'actionnement (10, 11, 12) a un premier état d'actionnement et un deuxième état d'actionnement dans lequel un actionnement progresse davantage à partir du premier état d'actionnement,
dans lequel ladite portion d'actionnement inclut un commutateur de type à bouton-poussoir, et
dans lequel le premier état d'actionnement est un état enfoncé à moitié du commutateur de type à bouton-poussoir, et le deuxième état d'actionnement est un état dans lequel le commutateur de type à bouton-poussoir est enfoncé davantage à partir de l'état enfoncé à moitié ; et
dans lequel l'unité de commande (7) est configurée pour identifier une portion d'actionnement (10, 11, 12) à actionner, sur la base d'un signal de détection des unités de détection d'état actionné (13) transmis à l'unité de commande (7) ;
dans lequel l'unité d'affichage (9) a une fonction d'affichage de contenu d'actionnement qui affiche le contenu d'actionnement de l'instrument médical (2, 2A, 2B, 2C) correspondant à la portion d'actionnement (10, 11, 12) dont l'état actionné a été détecté par les unités de détection d'état actionné (13) ;
dans lequel, lorsque ladite portion d'actionnement est dans le premier état de fonctionnement, la fonction d'affichage de contenu d'actionnement doit afficher le contenu d'actionnement des instruments médicaux (2, 2A, 2B, 2C) correspondants, et
lorsque ladite portion d'actionnement atteint le deuxième état d'actionnement, l'instrument médical (2, 2A, 2B, 2C) correspondant est configuré pour effectuer un actionnement prédéterminé.

2. Robot chirurgical (1) selon la revendication 1, dans lequel l'unité d'affichage (9) a une fonction qui peut être sélectionnée pour désactiver l'affichage de la marque (14) et/ou de la lettre.

3. Robot chirurgical (1) selon la revendication 1 ou 2, dans lequel la fonction d'affichage de contenu d'actionnement doit afficher une marque (15) qui suggère le contenu d'actionnement.

4. Robot chirurgical (1) selon la revendication 3, dans lequel la marque (15) qui suggère le contenu d'actionnement est affichée de manière à chevaucher au moins partiellement l'instrument médical (2, 2A, 2B, 2C).

5. Robot chirurgical (1) selon l'une quelconque des revendications 1 à 4, dans lequel la fonction d'affichage de contenu d'actionnement efface un affichage du contenu d'actionnement à l'expiration d'un temps donné après l'affichage du contenu d'actionnement sur l'écran (8, 8A, 8B, 8C) de l'unité d'affichage (9).

6. Robot chirurgical (1) selon l'une quelconque des revendications 1 à 5, dans lequel l'unité d'affichage (9) a une fonction qui invalide la fonction d'affichage de contenu d'actionnement.

7. Robot chirurgical (1) selon l'une quelconque des revendications 1 à 6, dans lequel l'unité de détection d'état actionné est un contact et/ou un capteur de proximité (13).

8. Robot chirurgical (1) selon l'une quelconque des revendications 1 à 7, dans lequel l'unité d'affichage (9) a en outre une fonction d'affichage de commutateur qui affiche divers commutateurs, et
dans lequel l'unité de saisie (6, 6A, 6B, 6C) a une portion d'actionnement configurée pour actionner un commutateur souhaité parmi les divers commutateurs.

9. Robot chirurgical (1) selon l'une quelconque des revendications 1 à 8, dans lequel l'unité de saisie (6, 6A, 6B, 6C) comprend une pluralité d'unités de saisie (6, 6A, 6B, 6C), l'unité d'affichage (9) ayant une pluralité d'affichages qui correspondent respectivement à la pluralité d'unités de saisie (6, 6A, 6B, 6C).

10. Robot chirurgical (1) selon l'une quelconque des revendications 1 à 9, dans lequel l'unité de saisie (6, 6A, 6B, 6C) a une portion d'actionnement mobile configurée pour déplacer au moins l'un de la pluralité d'instruments médicaux (2, 2A, 2B, 2C), et
dans lequel l'unité d'affichage (9) règle un agrandissement d'une quantité d'actionnement de l'instrument médical (2, 2A, 2B, 2C) par rapport à une quantité d'actionnement de la portion d'actionnement mobile à une réciproque d'un agrandissement d'affichage de l'instrument médical (2, 2A, 2B, 2C).

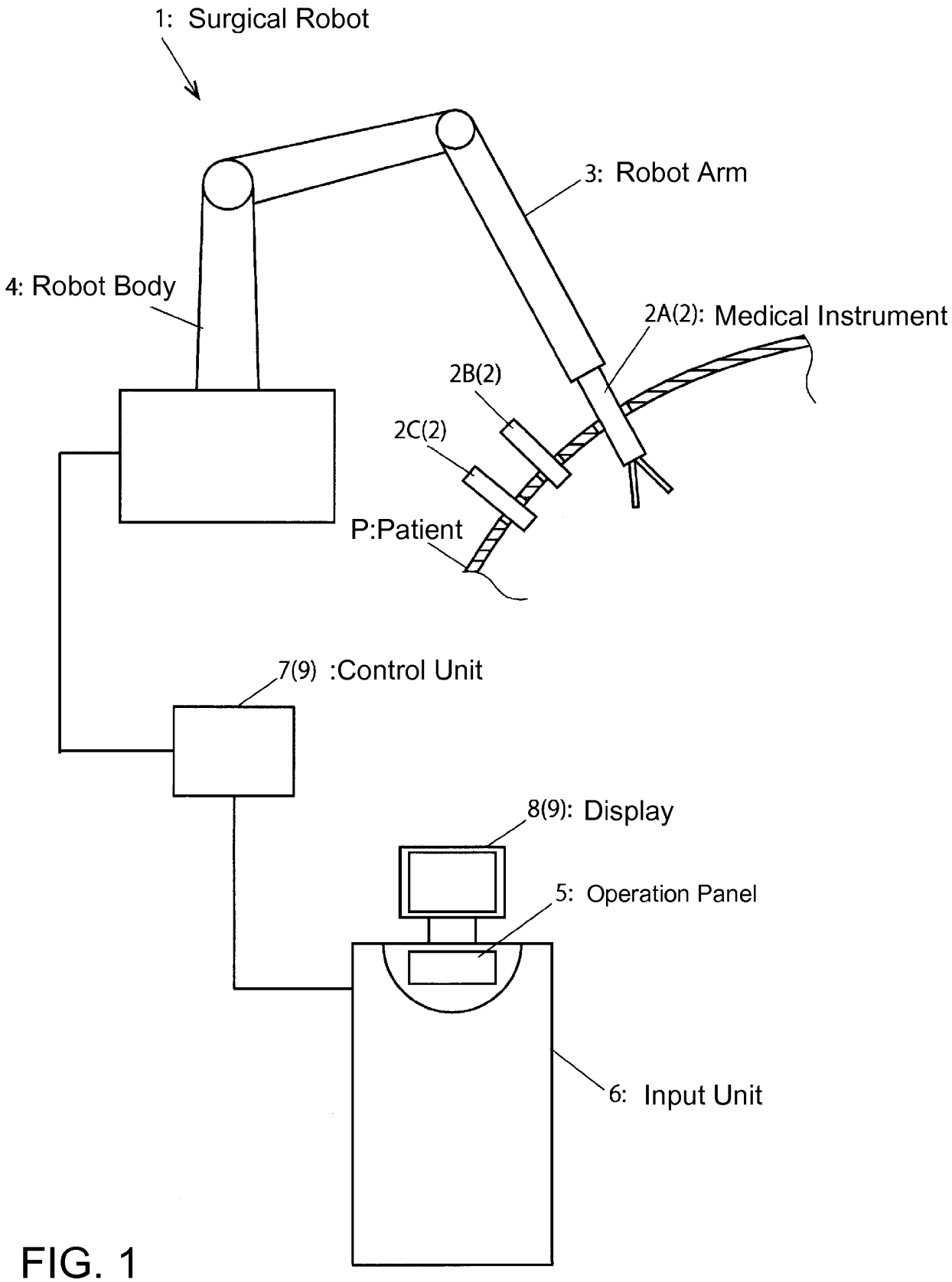
1: Surgical Robot
3: Robot Arm
4: Robot Body
2A(2): Medical Instrument
2B(2)
2C(2)
P:Patient
7(9) :Control Unit
8(9): Display
5: Operation Panel
6: Input Unit

FIG. 1

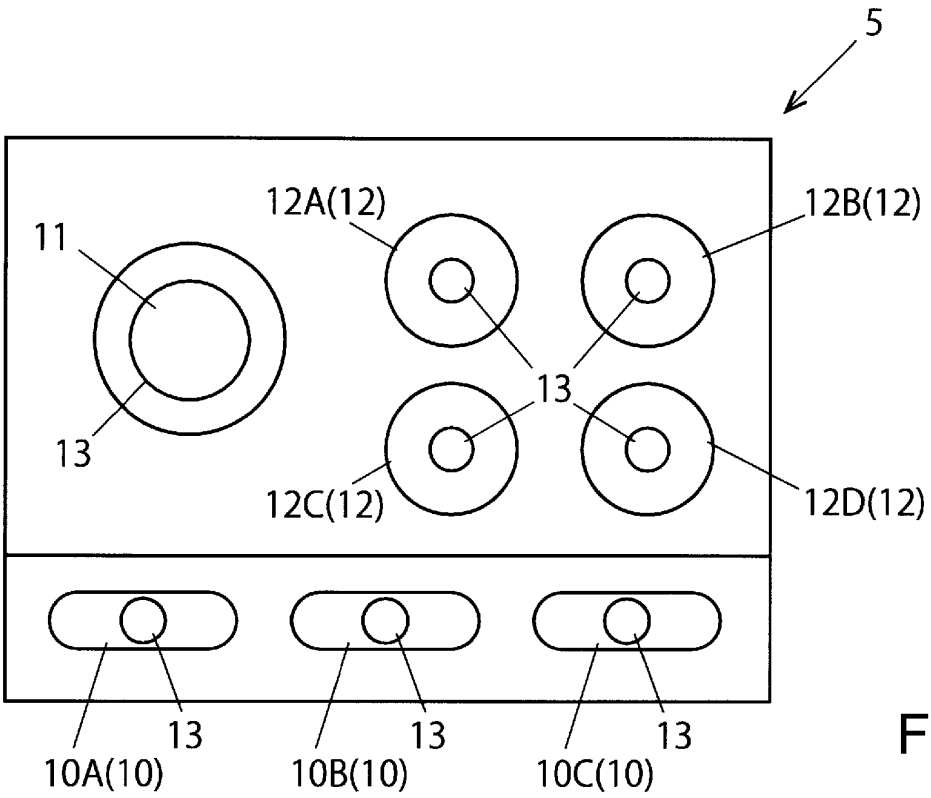
5
11
12A(12)
12B(12)
13
13
12C(12)
12D(12)
13
13
13
10A(10)
10B(10)
10C(10)

FIG. 2A

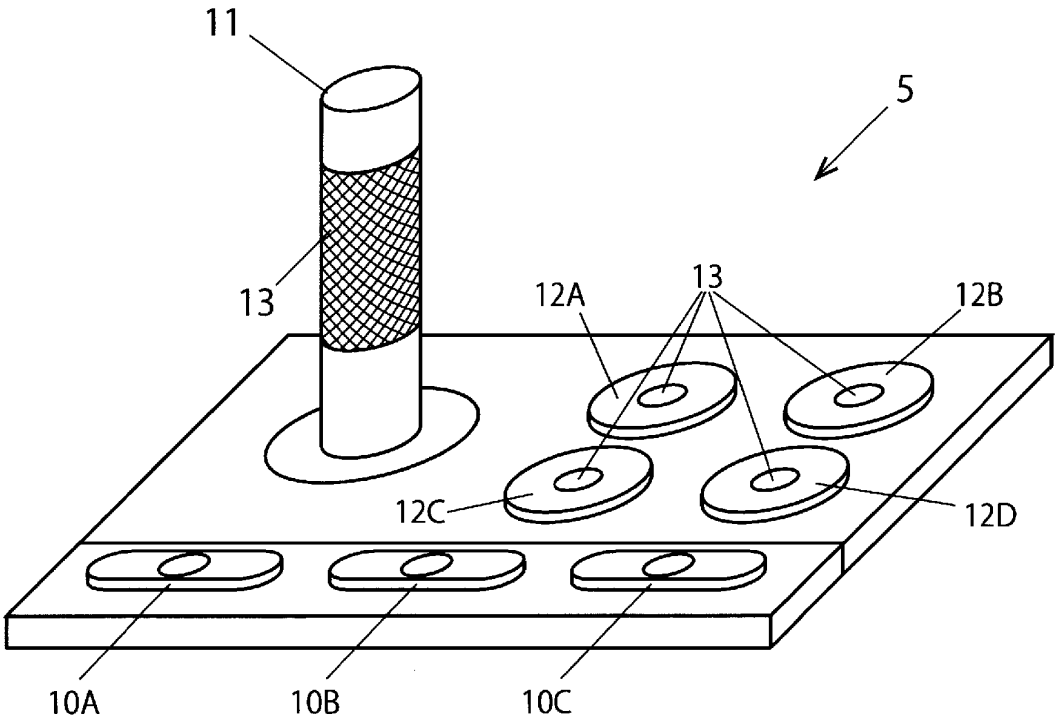
11
5
13
12A
13
12B
12C
12D
10A
10B
10C

FIG. 2B

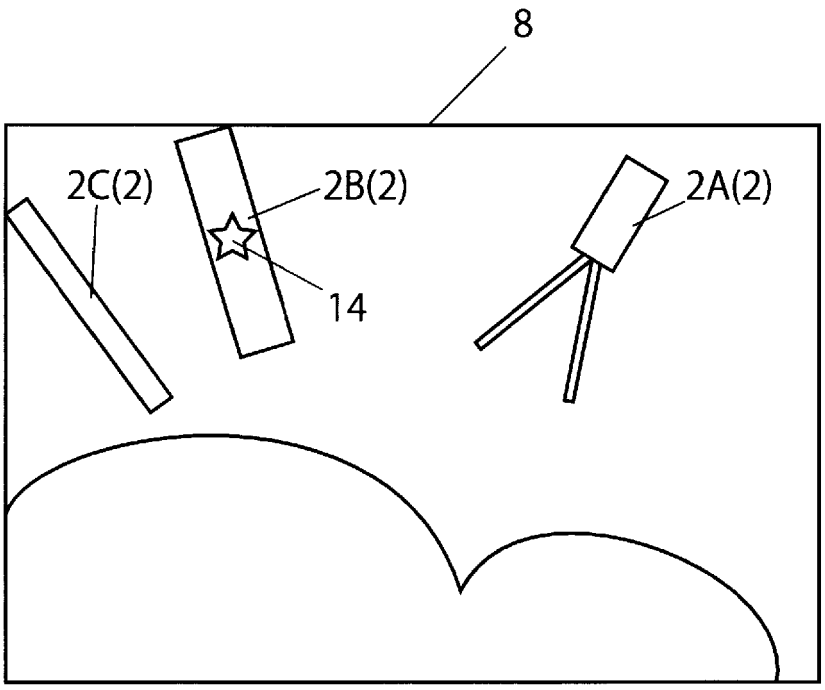

FIG. 3

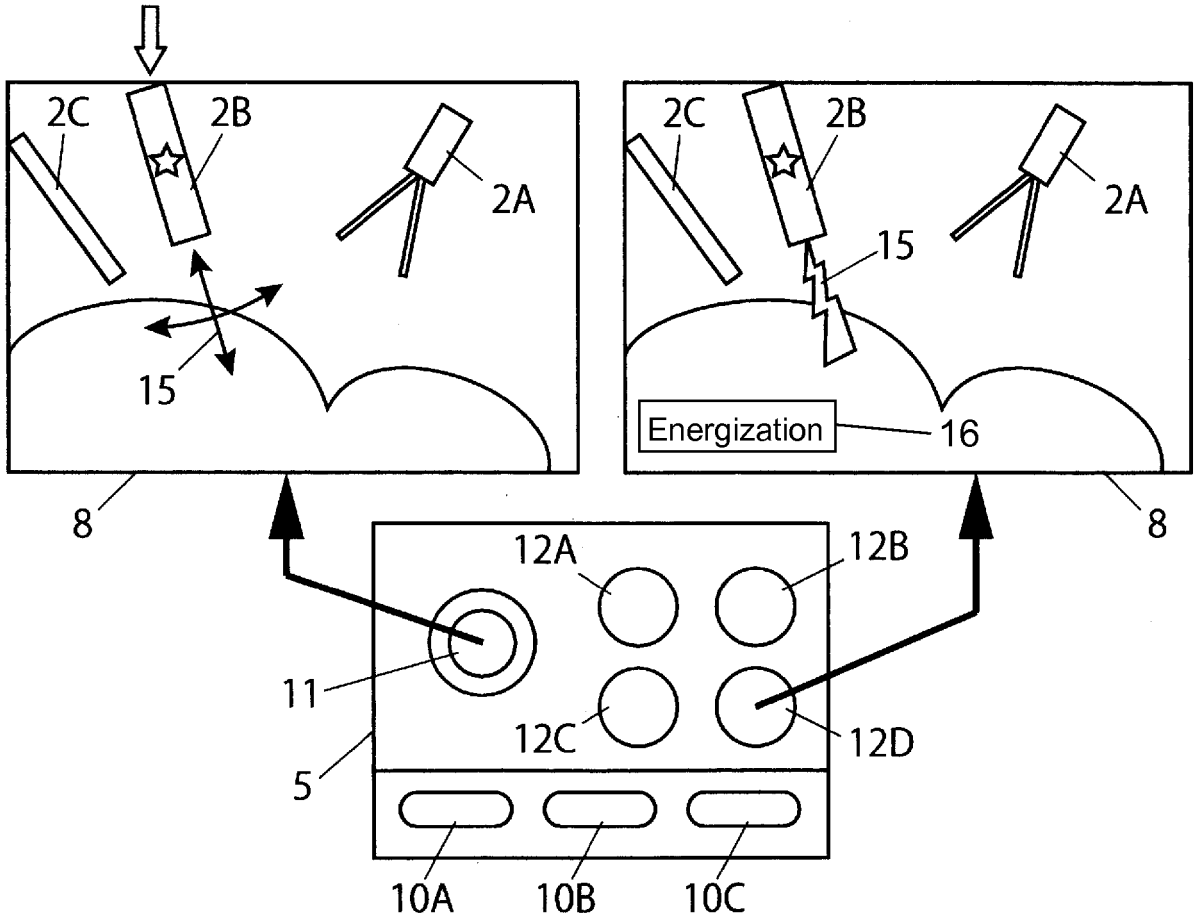
This Medical Instrument has been selected.
2C
2B
2A
15
8
2C
2B
2A
15
Energization
16
8
12A
12B
11
12C
12D
5
10A
10B
10C

FIG. 4

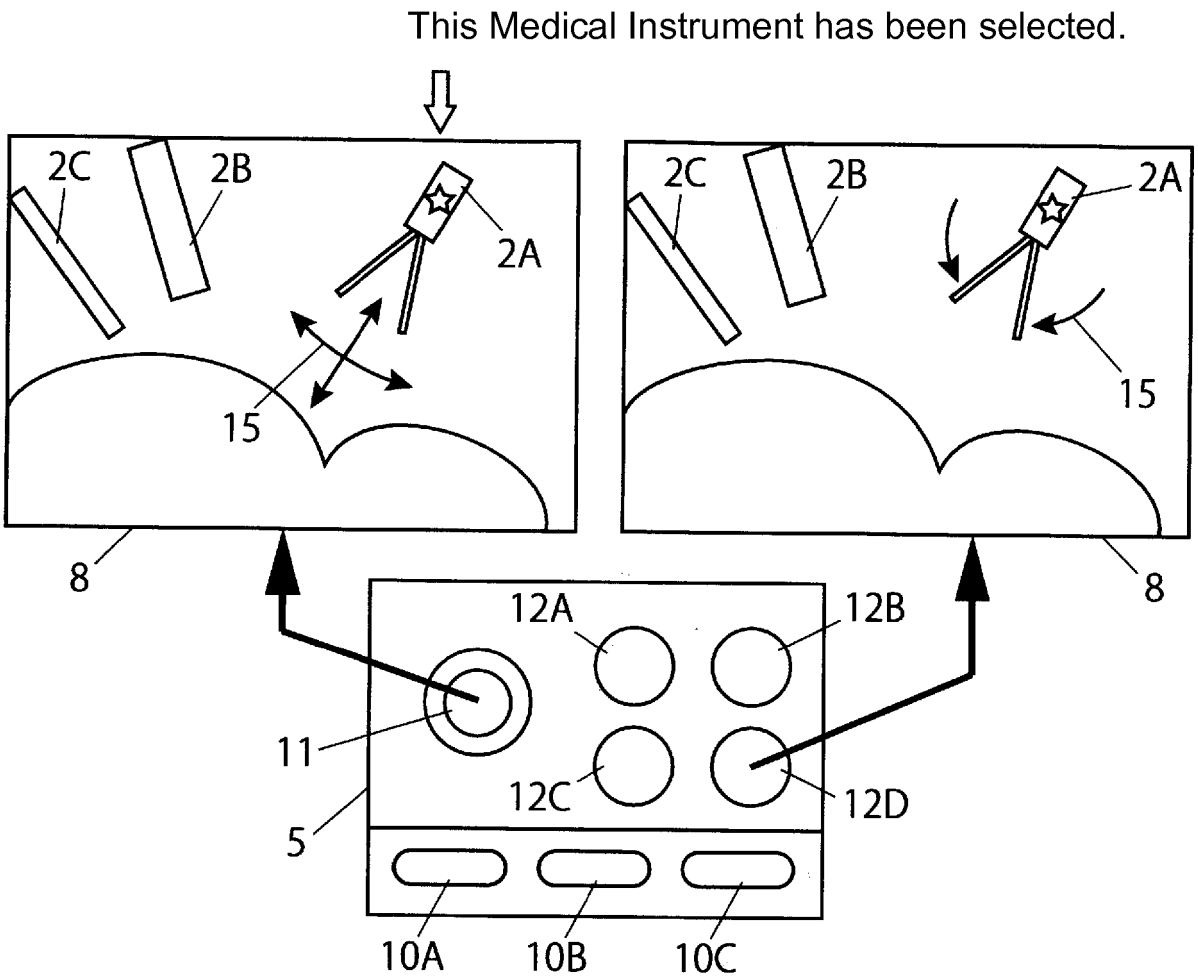
This Medical Instrument has been selected.
2C
2B
2A
15
8
2C
2B
2A
15
8
12A
12B
11
12C
12D
5
10A
10B
10C

FIG. 5

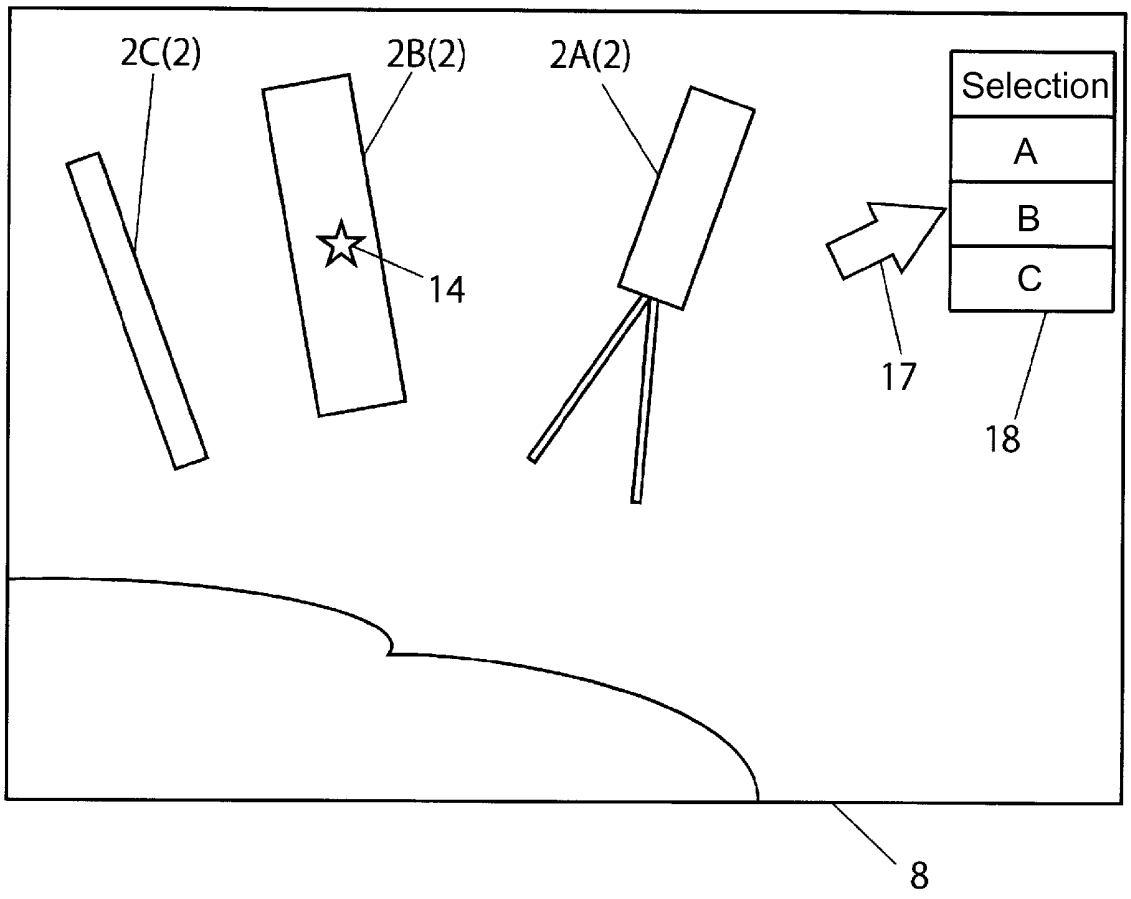
2C(2)
2B(2)
2A(2)
Selection
A
B
C
14
17
18
8

FIG. 6A

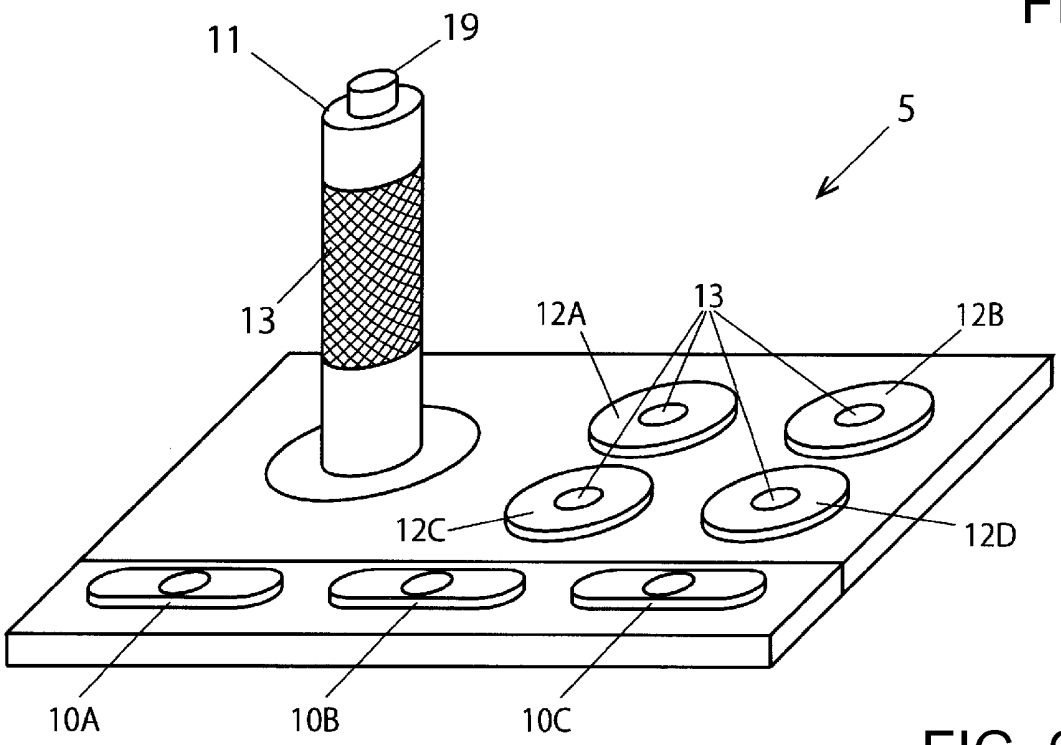
11
19
5
13
12A
13
12B
12C
12D
10A
10B
10C

FIG. 6B

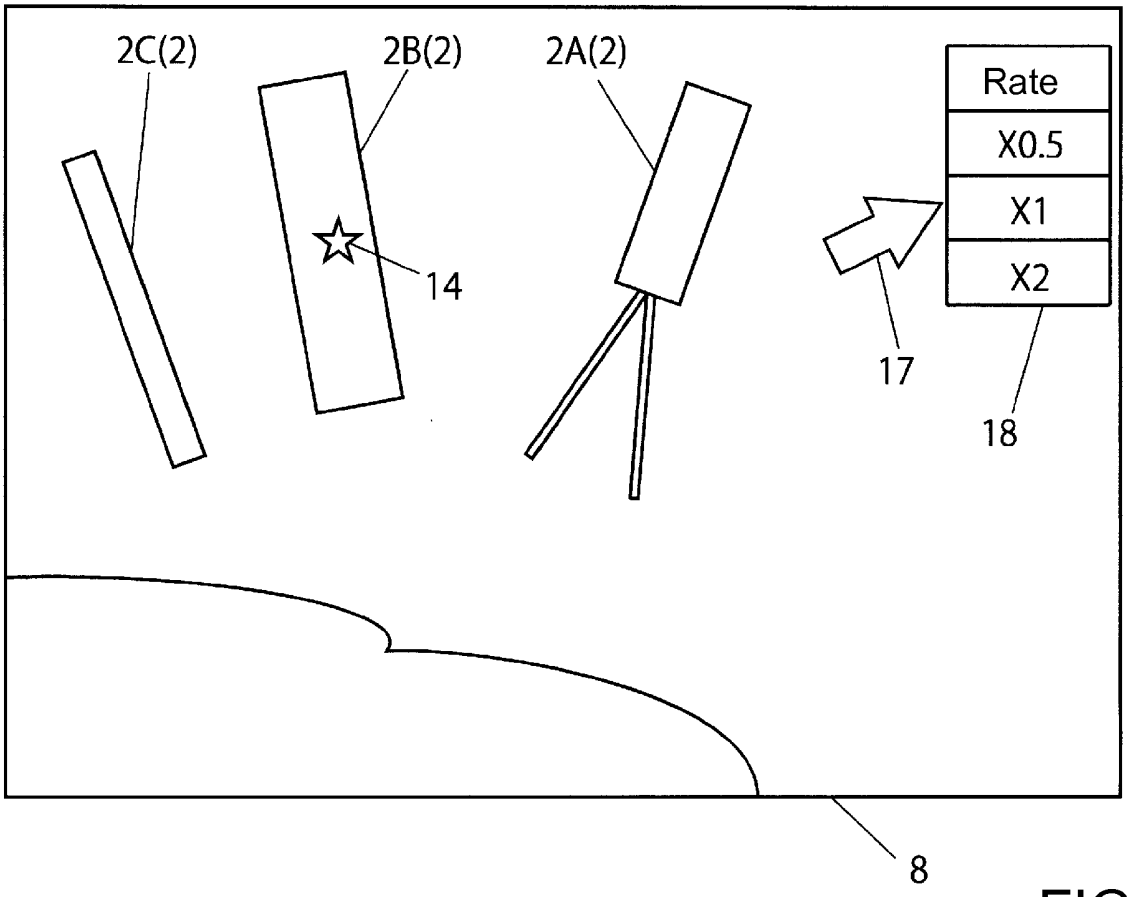
2C(2)
2B(2)
2A(2)
14
Rate
X0.5
X1
X2
17
18
8

FIG. 7A

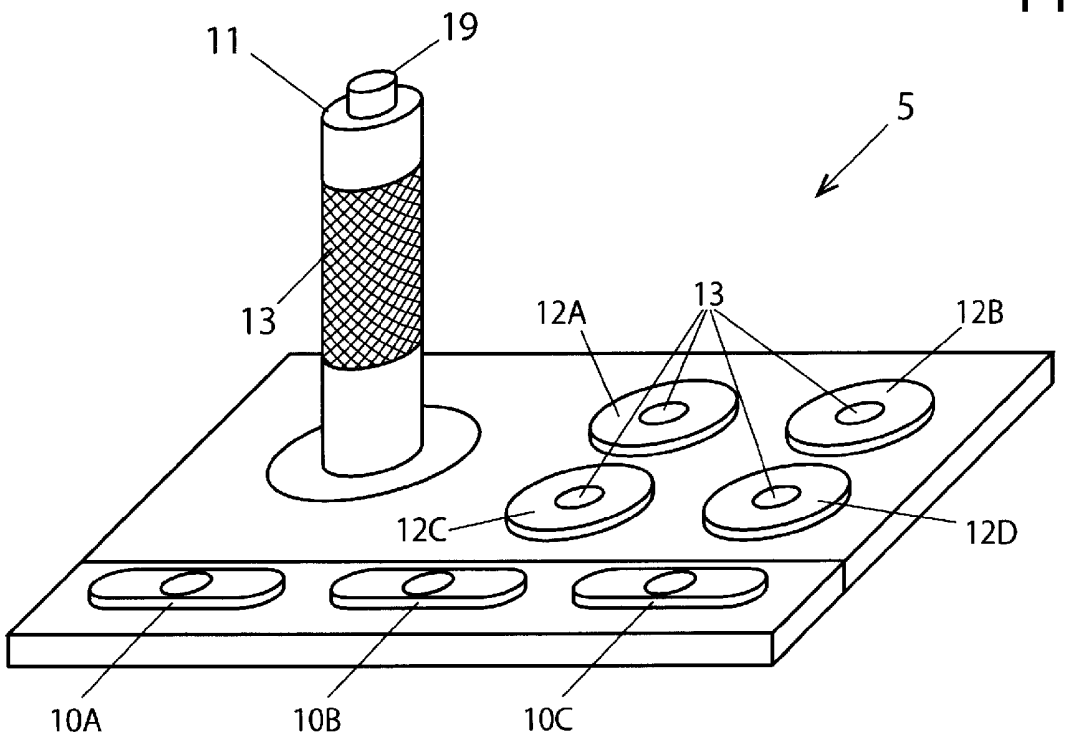
11
19
5
13
12A
13
12B
12C
12D
10A
10B
10C

FIG. 7B

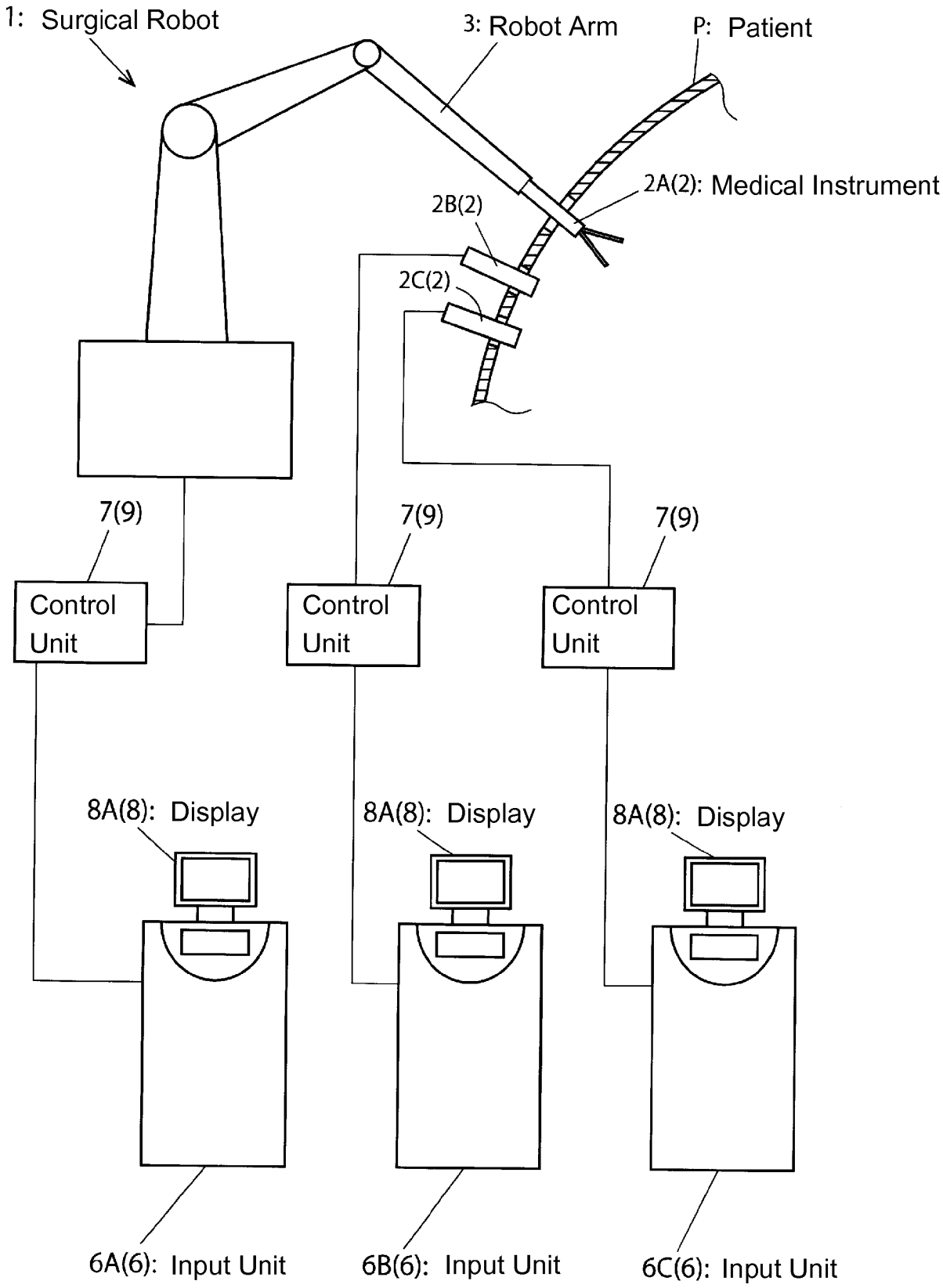
1: Surgical Robot
3: Robot Arm
P: Patient
2A(2): Medical Instrument
2B(2)
2C(2)
7(9)
7(9)
7(9)
Control Unit
Control Unit
Control Unit
8A(8): Display
8A(8): Display
8A(8): Display
6A(6): Input Unit
6B(6): Input Unit
6C(6): Input Unit

FIG. 8

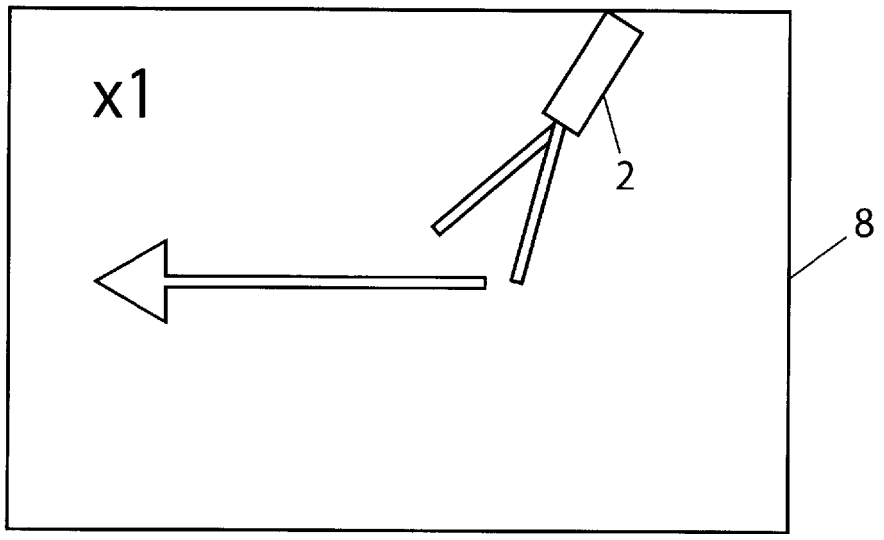

FIG. 9A

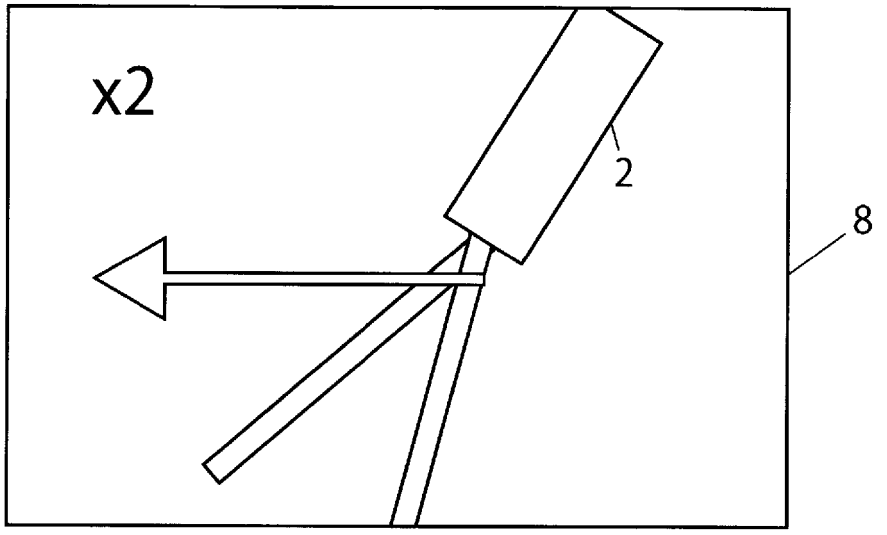

FIG. 9B

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 2010228249 A1 **[0004]**
- WO 2011116332 A2 **[0005]**
- WO 2007137304 A2 **[0006]**
- US 2010198402 A1 **[0007]**
- US 2011306986 A1 **[0008]**
- JP 2001104333 A **[0009]**